# An Assessment of Risk Factors Impacting the Cost of Contractor-Led Design and Build Projects

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Royal Institution of Chartered Surveyors

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London

SW1P 3AD

United Kingdom

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# AN ASSESSMENT OF RISK FACTORS IMPACTING THE COST OF CONTRACTOR-LED DESIGN AND BUILD PROJECTS

**Henry Odeyinka[1], Keren Larkin[2], Robert Eadie[3] & Gervase Cunningham[4]**

*[1]Department of Quantity Surveying, Obafemi Awolowo University, Ile-Ife, Nigeria*
*[2,3&4]School of the Built Environment, University of Ulster, Jordanstown, Belfast BT37 0QB, UK*

## ABSTRACT

Procurement in use surveys have confirmed a steady increase in the use of design and build procurement method. However, there was also a criticism that the out turn cost of design and build procurement method makes it more expensive than the traditional procurement method. The conjecture in this study is that risk factors inherent in design and build projects are responsible for the observed variance between the contract sum and the out turn cost. Using a set of 37 risk factors, the study utilized an online survey of UK-based construction professionals to evaluate risk impacts on the variance between contract sum and final account in contractor-led design and build projects. Survey responses were analyzed using mean ranking analysis and one-way analysis of variance (ANOVA). Result showed that 'scope changes', 'ambiguous client brief', 'scope creep', 'insufficient design completion during tender', and 'change in employer's requirement' are top risk factors impacting the variance between contract sum and final account. The implication of this finding is that it alerts the design and build contractors to specific risk factors they need to pay attention to in their delivery of design and build projects and to devise a proactive approach to their management so as to avoid significant cost overrun.

Keywords: contract sum, cost overrun, design and build, final account, risk factors.

## INTRODUCTION

Design and Build procurement is an arrangement where one contracting organisation takes sole responsibility, normally on a lump sum basis, for the bespoke design and construction of a client's project up to its practical/ substantial completion Greenhalgh and Squires (2011). Hughes, *et al*., (2006) concluded that in practice design and build is generally structured in one of two ways; either the client employs a dedicated design and build contractor with their own in house design team or the client engages a general building contractor who employs external design consultants to join the contractor's team for the duration of the project.

The Royal Institution of Chartered Surveyors (2007) carried out a contract in use survey and concluded that there was a steady increase in the use of design and build procurement method. The Chartered Institute of Building (2010) also carried out a procurement in use survey and concluded that on projects between £5m-50m, design and build was seen as most suitable. It has been observed (CIOB 2010) that design and

[1] E-mail: hodeyinka@yahoo.com
[2] E-mail: larkin-k1@email.ulster.ac.uk
[3] E-mail: r.eadie@ulster.ac.uk
[4] E-mail: g.cunningham@ulster.ac.uk

build procurement method is popular with clients, as the risk primarily lies with the contractor and the process is relatively easy to understand – the project is specified to be designed (at least in part) and built by the same contractor, which, in theory, allows for greater communication. Other parts of the design phase may be carried out by consultants hired by the client, though the contractor will be informed of developments during the phase. Ideally, the Design and Build procurement is expected to bring both teams working in partnership, with the contractors giving feasibility input in the design stage, and the architect advising on site during the construction phase. Both are expected to result in a more integrated approach, as set out in the Latham Report 'Constructing the Team' (Latham, 1994).

In spite of its expected advantages, design and build procurement is not always as straightforward as it is portrayed to be and there can be numerous risk factors that make it difficult for the out turn cost to equate the contract sum. In some cases, the out turn cost even makes it more expensive than the traditional method of procurement. The conjecture in this study is that risk factors inherent in design and build projects are responsible for the observed variance between the contract sum and the out turn cost. The objective of the study is therefore to assess the risk factors impacting the cost of contractor-led design and build projects in the UK construction industry. The study is significant as it complements an earlier study (Odeyinka *et al.*, 2012) that explored risk impacts on the variability between contract sum and final account in traditional procurement.

## AN OVERVIEW OF DESIGN AND BUILD PROCUREMENT METHOD

Several authors have recognised different variations of design and build procurement methods. Greenhalgh and Squires (2011) identified four different variations of design and build including novated design and build, develop and construct, package deal and turnkey method. Davis *et. al.* (2008) identified five different variations of design and build including novated design and build, develop and construct, package deal, direct and competitive. Greenhalgh and Squires (2011) observed that in these first two variants (novated design and build and develop and construct) the client's input into the design is substantial. They therefore generically named them as client-led design and build. They also observed that in the next two variants (package deal and turnkey) the client's input into the design is extremely limited. They therefore generically named them as contractor-led design and build

The additional variants of direct design and build and competitive design and build identified by Davis *et. al.* (2008) addressed more of the tendering processes employed in choosing a design and build contractor. According to them, direct design and build implies that no competition is obtained in tenders, there may be some appraisal of the possible competitors before tendering but only one tender will actually be made. With competitive design and build, Davis *et. al.* (2008) submitted that tenders are obtained by documents prepared by competitors, this allows contractors to offer some competition with regards to designs and prices.

## RISK FACTORS IN DESIGN AND BUILD PROCUREMENT

A review of various authors (Hughes, *et al*., 2006, Davis *et. al.*, 2008, Greenhalgh and Squires, 2011, JCT Design and Build Contract, 2011) shows that various risk factors abound which potentially impact on the cost of contractor-led design and build projects. These include ambiguous client brief, scope creep, change in employers' requirement, inaccurate estimating, schedule slippage, lack of clarity in contractor's proposals, delay to work due to third party, inadequate specification, errors and omissions in tender document, late or non-approval of contractor's design, unforeseeable ground conditions, subcontractors' misinterpretation of the contract, contract document conflicts, defective construction works, default of sub-contractor, local concerns and requirements, incompetent subcontractors, lack of knowledge of design process by D&B contractors, ambiguous contract provisions, delay in resolving disputes, misunderstanding of the contract, suppliers not being able to hold firm prices, delay in availability of labour, materials or equipment, unexpected environmental issues, increased cost of utility diversions, project funding problems, default of contractor, damage to existing utility services, price fluctuations, change in relevant regulations, default of employer, contractor's insolvency and act of God. The conjecture in this study is that these risk factors combine to impact the out turn cost of design and build projects. The specific objective of the study is to assess the extent of occurrence and the associated impacts of the identified risk factors.

## DATA AND RESEARCH METHODS

The study employed a survey research design method. Data were obtained using a structured questionnaire survey of risk factors impacting contractor-led design and build projects. A total of 37 risk factors were derived from literature and from consultation with professionals involved in design and build projects. Online questionnaire survey was administered on a purposive sample of UK-based construction professionals involved in contracting organisations who have worked on new build and refurbished contractor-led design and build projects. A total of 150 potential respondents were contacted by e-mail to seek their approval to participate in the online survey. About 75 respondents replied to our e-mail request indicating their willingness to participate in the survey out of which 50 completed the survey.

Table 1 shows the demographic profile of the respondents. From the Table, it is evident that respondents to the survey included Project Managers, Contractors, Contractors' Quantity Surveyors, Civil/ Structural Engineers and Mechanical and Electrical Engineers. It is also evident from the Table that about 74% of the respondents are educated up to Diploma and first degree level and a further 26% have postgraduate qualifications. In addition, about 86% of the respondents are professionally registered. The demographic profile of the respondents therefore suggests that they are well educated and professionally qualified. As a result, the responses provided by them could be relied upon.

Using a project-by-project approach and exploring the two-dimensional nature of risk, respondents were asked to score on a Likert-type scale of 0-5, the extent to which the identified risk factors occurred in their nominated building projects and their associated impacts. The Likert-type scale used for the two-dimensional scaled questionnaire was defined as follows: 0 – no risk occurrence and no impact, 1 – very

low extent of occurrence and very low impact, 2 – low extent of occurrence and low impact, 3 – medium extent of occurrence and medium impact, 4 – high extent of occurrence and high impact, 5 – very high extent of occurrence and very high impact. This then gives the measuring scale the property of an interval scale, which makes the collected data suitable for various statistical analyses.

Responses to the questionnaire survey were analysed using the mean score analysis, which were subsequently ranked in order to determine the relative importance of the risk factors considered.

Table 1: Respondents' Background Information

| Background Information | Parameters | Frequency | Percent | Cumulative Percent |
|---|---|---|---|---|
| Respondents' Designation | Project Manager | 10 | 20 | 20 |
| | Contractor | 7 | 14 | 34 |
| | Contractor's Quantity Surveyor | 25 | 50 | 84 |
| | Civil/ Structural Engineer | 5 | 10 | 94 |
| | Mechanical and Electrical Engineer | 3 | 6 | 100 |
| | Total | 50 | 100 | |
| Respondents' Academic Qualification | Diploma | 3 | 6 | 6 |
| | BSc | 9 | 18 | 24 |
| | BSc (Hons)/ B Eng. | 25 | 50 | 74 |
| | MSc/ M Eng./ MBA | 12 | 24 | 98 |
| | PhD | 1 | 2 | 100 |
| | Total | 50 | 100 | |
| Respondents' Professional Qualification | MRICS/FRICS | 26 | 52 | 52 |
| | CENG | 9 | 18 | 70 |
| | MCIOB/ FCIOB | 8 | 16 | 86 |
| | None | 7 | 14 | 100 |
| | Total | 50 | 100 | |
| Respondents' Company's Annual Turnover | Up to £2 million | 14 | 28 | 28 |
| | Over £2 million and up to £10 million | 6 | 12 | 40 |
| | Over £10 million and up to £50 million | 11 | 22 | 62 |
| | Over £50 million | 19 | 38 | 100 |
| | Total | 50 | 100 | |
| Nature of Projects handled by Respondents | New build | 38 | 76 | 76 |
| | Refurbishment | 12 | 24 | 100 |
| | Total | 50 | 100 | |

## DATA ANALYSIS AND DISCUSSION OF FINDINGS

The summary of the mean response analysis result of construction professionals' perception of the extent of occurrence of the identified risk factors and their perceived impacts is shown in Table 2. The Table shows the ranked mean score analysis along the classifying categories of 'all projects surveyed', 'new build projects' and 'refurbishment projects'. The mean score analysis of the 'overall extent of risk

occurrence' ranges from 0.13 to 2.81. This suggests that the overall extent of risk occurrence ranges from almost no risk occurrence to medium level. The mean score analysis of the perceived impacts of risk occurrence(see Table 3) ranges from 0.12 to 2.80 which also indicates that the overall risk impacts range from almost no impact to medium level of impact. The same

**Table 2: Extent of Risk Occurrence in Contractor-led Design and Build Projects**

| Risk Factor | Overall Mean | Rank | New Build Mean | Rank | Refurb Mean | Rank | F-Values | *P*-Values |
|---|---|---|---|---|---|---|---|---|
| Scope changes | 2.81 | 1 | 2.57 | 1 | 3.50 | 1 | 3.554 | 0.066 |
| Ambiguous client brief | 2.43 | 2 | 2.26 | 2 | 2.92 | 2 | 1.688 | 0.200 |
| Scope creep | 2.34 | 3 | 2.17 | 3 | 2.83 | 3 | 1.622 | 0.209 |
| Change in employers' requirement | 2.04 | 4 | 1.94 | 4 | 2.33 | 4 | 0.708 | 0.404 |
| Inaccurate estimating | 1.62 | 5 | 1.77 | 5 | 1.17 | 14 | 1.601 | 0.212 |
| Schedule slippage | 1.53 | 6 | 1.46 | 6 | 1.75 | 6 | 0.311 | 0.580 |
| Lack of clarity in contractor's proposals | 1.45 | 7 | 1.17 | 14 | 2.25 | 5 | 9.907 | 0.003* |
| Delay to work due to third party | 1.43 | 8 | 1.46 | 6 | 1.33 | 10 | 0.063 | 0.802 |
| Inadequate specification | 1.40 | 9 | 1.37 | 11 | 1.50 | 7 | 0.075 | 0.786 |
| Errors and omissions in tender document | 1.36 | 10 | 1.46 | 6 | 1.08 | 16 | 0.724 | 0.399 |
| Late or non-approval of contractor's design | 1.36 | 10 | 1.40 | 9 | 1.25 | 13 | 0.096 | 0.759 |
| Unforeseeable ground conditions | 1.28 | 12 | 1.40 | 9 | 0.92 | 18 | 1.052 | 0.311 |
| Subcontractors' misinterpretation of the contract | 1.23 | 13 | 1.20 | 12 | 1.33 | 10 | 0.071 | 0.791 |
| Contract document conflicts | 1.21 | 14 | 1.11 | 15 | 1.50 | 7 | 0.691 | 0.410 |
| Defective construction works | 1.19 | 15 | 1.20 | 12 | 1.17 | 14 | 0.005 | 0.945 |
| Default of sub-contractor | 1.15 | 16 | 1.06 | 19 | 1.42 | 9 | 0.537 | 0.467 |
| Local concerns and requirements | 1.02 | 17 | 1.11 | 15 | 0.75 | 23 | 1.072 | 0.306 |
| Incompetent subcontractors | 1.00 | 18 | 1.09 | 17 | 0.75 | 23 | 0.677 | 0.415 |
| Lack of knowledge of design process by D&B contractors | 0.98 | 19 | 0.86 | 23 | 1.33 | 10 | 1.126 | 0.294 |
| Ambiguous contract provisions | 0.96 | 20 | 0.97 | 20 | 0.92 | 18 | 0.029 | 0.866 |
| Delay in resolving disputes | 0.96 | 20 | 1.09 | 17 | 0.58 | 28 | 1.213 | 0.277 |
| Misunderstanding of the contract | 0.91 | 22 | 0.91 | 21 | 0.92 | 18 | 0.000 | 0.995 |
| Suppliers not being able to hold firm prices | 0.83 | 23 | 0.89 | 22 | 0.67 | 25 | 0.320 | 0.574 |
| Delay in availability of labour, materials or equipment | 0.79 | 24 | 0.83 | 24 | 0.67 | 25 | 0.151 | 0.699 |
| Unexpected environmental issues | 0.77 | 25 | 0.80 | 25 | 0.67 | 25 | 0.094 | 0.761 |
| Increased cost of utility diversions | 0.74 | 26 | 0.80 | 25 | 0.58 | 28 | 0.229 | 0.635 |
| Project funding problems | 0.72 | 27 | 0.66 | 27 | 0.92 | 18 | 0.461 | 0.501 |
| Default of contractor | 0.62 | 28 | 0.49 | 30 | 1.00 | 17 | 1.643 | 0.207 |
| Damage to existing utility services | 0.53 | 29 | 0.51 | 28 | 0.58 | 28 | 0.039 | 0.845 |
| Price fluctuations | 0.53 | 29 | 0.51 | 28 | 0.58 | 28 | 0.046 | 0.831 |
| Change in relevant regulations | 0.45 | 31 | 0.43 | 31 | 0.50 | 34 | 0.080 | 0.778 |
| Default of employer | 0.43 | 32 | 0.37 | 32 | 0.58 | 28 | 0.383 | 0.539 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Contractor's insolvency | 0.36 | 33 | 0.17 | 35 | 0.92 | 18 | 5.895 | 0.019* |
| Act of God | 0.34 | 34 | 0.37 | 32 | 0.25 | 36 | 0.163 | 0.689 |
| Loss or damage by fire or flood | 0.32 | 35 | 0.26 | 34 | 0.50 | 34 | 0.857 | 0.360 |
| Employer's insolvency | 0.15 | 36 | 0.00 | 37 | 0.58 | 28 | 6.542 | 0.014* |
| Labour strikes | 0.13 | 37 | 0.09 | 36 | 0.25 | 36 | 0.987 | 0.326 |

*Significant at 5% level

**Table 3: Impact of Risk Occurrence in Design and Build Projects**

| Risk Factor | Overall Mean | Rank | New Build Mean | Rank | Refurb Mean | Rank | *F* - Stat | *P* - Value |
|---|---|---|---|---|---|---|---|---|
| Scope changes | 2.80 | 1 | 2.66 | 1 | 3.25 | 1 | 1.292 | 0.261 |
| Ambiguous client brief | 2.42 | 2 | 2.29 | 2 | 2.83 | 2 | 0.956 | 0.333 |
| Scope creep | 2.40 | 3 | 2.26 | 3 | 2.83 | 2 | 1.070 | 0.306 |
| Change in employers' requirement | 2.16 | 4 | 2.11 | 4 | 2.33 | 4 | 0.203 | 0.654 |
| Inaccurate estimating | 1.68 | 5 | 1.84 | 5 | 1.17 | 12 | 1.399 | 0.243 |
| Unforeseeable ground conditions | 1.60 | 6 | 1.71 | 6 | 1.25 | 10 | 0.663 | 0.420 |
| Errors and omissions in tender document | 1.54 | 7 | 1.61 | 7 | 1.33 | 7 | 0.290 | 0.593 |
| Schedule slippage | 1.48 | 8 | 1.39 | 10 | 1.75 | 6 | 0.471 | 0.496 |
| Late or non-approval of contractor's design | 1.42 | 9 | 1.61 | 8 | 0.83 | 18 | 2.355 | 0.131 |
| Lack of clarity in contractor's proposals | 1.40 | 10 | 1.18 | 15 | 2.08 | 5 | 5.011 | 0.030* |
| Inadequate specification | 1.34 | 11 | 1.34 | 11 | 1.33 | 7 | 0.000 | 0.985 |
| Contract document conflicts | 1.30 | 12 | 1.29 | 13 | 1.33 | 7 | 0.008 | 0.927 |
| Delay to work due to third party | 1.30 | 12 | 1.42 | 9 | 0.92 | 16 | 1.208 | 0.277 |
| Defective construction works | 1.16 | 14 | 1.32 | 12 | 0.67 | 22 | 1.904 | 0.174 |
| Subcontractors' misinterpretation of the contract | 1.10 | 15 | 1.18 | 15 | 0.83 | 18 | 0.824 | 0.368 |
| Delay in resolving disputes | 1.08 | 16 | 1.11 | 17 | 1.00 | 14 | 0.043 | 0.837 |
| Local concerns and requirements | 1.04 | 17 | 1.21 | 14 | 0.50 | 29 | 4.877 | 0.032* |
| Lack of knowledge of design process by D&B contractors | 0.98 | 18 | 0.89 | 23 | 1.25 | 10 | 0.589 | 0.447 |
| Incompetent subcontractors | 0.94 | 19 | 1.05 | 18 | 0.58 | 24 | 1.585 | 0.214 |
| Misunderstanding of the contract | 0.94 | 19 | 0.95 | 21 | 0.92 | 16 | 0.006 | 0.939 |
| Ambiguous contract provisions | 0.88 | 21 | 0.89 | 23 | 0.83 | 18 | 0.038 | 0.846 |
| Default of sub-contractor | 0.86 | 22 | 0.89 | 23 | 0.75 | 20 | 0.118 | 0.733 |
| Increased cost of utility diversions | 0.86 | 22 | 1.00 | 19 | 0.42 | 29 | 1.537 | 0.221 |
| Suppliers not being able to hold firm prices | 0.84 | 24 | 1.00 | 19 | 0.33 | 31 | 3.105 | 0.084 |
| Unexpected environmental issues | 0.82 | 25 | 0.92 | 22 | 0.50 | 26 | 0.884 | 0.352 |
| Delay in availability of labour, materials or equipment | 0.70 | 26 | 0.76 | 26 | 0.50 | 26 | 0.633 | 0.430 |
| Project funding problems | 0.70 | 26 | 0.61 | 29 | 1.00 | 14 | 0.841 | 0.364 |
| Default of contractor | 0.68 | 28 | 0.55 | 31 | 1.08 | 13 | 1.498 | 0.227 |
| Change in relevant regulations | 0.60 | 29 | 0.63 | 28 | 0.50 | 26 | 0.131 | 0.719 |
| Damage to existing utility services | 0.60 | 29 | 0.66 | 27 | 0.42 | 29 | 0.414 | 0.523 |
| Price fluctuations | 0.52 | 31 | 0.58 | 30 | 0.33 | 31 | 0.575 | 0.452 |
| Default of employer | 0.42 | 32 | 0.34 | 34 | 0.67 | 22 | 0.900 | 0.347 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Contractor's insolvency | 0.38 | 33 | 0.26 | 35 | 0.75 | 20 | 1.801 | 0.186 |
| Loss or damage by fire or flood | 0.38 | 33 | 0.39 | 32 | 0.33 | 31 | 0.040 | 0.843 |
| Acts of God | 0.36 | 35 | 0.37 | 33 | 0.33 | 31 | 0.016 | 0.900 |
| Employer's insolvency | 0.26 | 36 | 0.16 | 36 | 0.58 | 24 | 1.724 | 0.195 |
| Labour strikes | 0.12 | 37 | 0.08 | 37 | 0.25 | 35 | 0.984 | 0.326 |

*Significant at 5% level

trend was observable for 'new build' and 'refurbishment' projects. This observed trend shows that contractor-led design and build projects seemed to be less risky than traditional procurement method (see Odeyinka *et al.* 2012). It is also evident from Table 2 that the top ranking risk factors are 'scope changes', 'ambiguous client brief', 'scope creep', 'change in employers' requirement' and 'inaccurate estimating.' These top risk factors all bother on uncertain employer's requirement. It is therefore noteworthy that for cost certainty to be guaranteed in contractor-led design and build, employers also need to be certain in their requirements.

It is also worthy of note that respondents appeared to be unanimous in their scoring of the extent of risk occurrence and its impact in both new build and refurbishment projects. This is because the Analysis of Variance (ANOVA) did not show statistical significant differences in the mean scores of the extent of risk occurrence and its impact for the majority of the risk factors (see Tables 2 and 3). However, it is evident from Table 2 that there is a statistical difference of opinion in respondents' scoring of 'Lack of clarity in contractor's proposals' risk factor (*p*-value = 0.003). Whilst this factor ranked 7$^{th}$ overall, it ranked 14$^{th}$ under new build projects while it ranked 5$^{th}$ under refurbishment projects. This is not a surprise because refurbishment projects by nature have a lot of things concealed until construction starts, making it difficult for contractors to be very clear in their proposal at the tender stage. On the other hand, it is easier for contractors to have clearer proposal for new build at the tender stage. The *p*-values from the ANOVA also show that there is statistical significant differences of opinion among the respondents in their scoring of 'Contractor's insolvency' (*p*-value = 0.019) and 'Employer's insolvency' (*p*-value = 0.014) risk factors. Again, this is not a surprise because as a result of lack of clarity in contractor's proposal at the tender stage, they may need more money than budgeted for under refurbishment projects than in new build projects, thus making the contractor more prone to insolvency under refurbishment projects than with new build. The same situation also applies to the employer whereby due to lack of clarity in contractor's proposal at the tender stage, he suddenly realizes that more money is required than budgeted for especially with refurbishment projects.

It is also interesting to note from Tables 2 and 3 that about a half of the 37 identified risk factors have mean scores of less than one both in terms of extent of occurrence and impact in cases of occurrence. This suggests that in all the projects surveyed, those risk factors either did not occur at all or very low in extent of occurrence as well as impact in cases of occurrence. This implies that the majority of risk factors that that weigh higher under the traditional procurement method (see Odeyinka *et al.*, 2012) are of no consequence under the design and build procurement method. This may explain why there is a growing trend in the use of design and build as a procurement method.

## CONCLUSION

Within the limitation of the data collected, it can be concluded that the significant risk factors impacting the variability between tender sum and final account in contractor-led design and build project relate to the level of clarity in client's brief at the tender stage. Those significant risk factors include 'scope changes', 'ambiguous client brief', 'scope creep', 'change in employers' requirement' and 'inaccurate estimating.' These

significant risk factors all bother on uncertain employer's requirement. This finding corroborates Winch's (2010) assertion that the more information is available at the pre-construction stage, the less risk to contend with during construction and the more certain the cost of construction will be.

It can also be concluded that the nature of a project, i.e. whether new build or refurbishment have implications on the level of clarity in contractor's proposal. Contractors seem to be in a better position to present clearer proposals under new build than under refurbishment design and build projects. Contractors and employers' proneness to insolvency also tend to be higher when handling refurbishment projects than new build design and build projects.
Finally, it is concluded from this study that about half of the risk factors identified as potentially impacting the cost of contractor-led design and build projects are of little or no consequence. This potentially explains the growing trend in the use of design and build procurement method over the traditional method of building procurement.

The study reported is part of an ongoing study and further work looks at risk factors impacting the cost of client-led design and build projects. It will also involve modelling risk impacts on the variability between contract sum and final account in design and build projects.

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